Effect of chemical treatment on the corrosion and bioactivity of equiatomic NiTi alloy

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Abstract

NiTi alloy in its equiatomic concentration is widely used in biomedical industry owing to its shape memory and superelasticity properties. The main problem facing for using it as implant materials is the possibility of elution of nickel, which is a known carcinogen. However, the elution rate can be reduced from the toxic limit to a reasonably safe level by adopting suitable surface modification techniques.

In the present study, the advantage of using ferric chloride, which is a common etchant for nickel was explored to modify the surface of NiTi alloy. NiTi alloy was chemically treated using acidified ferric chloride solution and post treated by annealing at 400 ^{o}C and passivation in nitric acid. The alloy surface after chemical treatment resulted in a nanogrid structure with a combination of one dimensional channel and two dimensional network-like patterns. The undulations formed after chemical treatment remained unaltered after annealing, while after passivation process the undulated surface was found to be filled with titanium oxides. XPS analysis revealed that the surface of passivated sample was enriched with oxides of titanium, predominantly as TiO_2. The corrosion potential, corrosion current density and breakdown potential were less noble for chemically treated NiTi alloy. The breakdown potential obtained for annealed surface was almost 200 mV higher than the passivated surface (0.8 V). Due to the decrease in surface nickel content and formation of compact titanium oxide, the overall resistance was in the range of mega ohms for passivated surfaces and the amount of nickel released after 14 days of immersion is almost half when compared to untreated NiTi alloy. Thus a combination of chemical treatment, annealing and passivation processes on NiTi alloy exhibits good bioactivity and corrosion resistance and may be considered suitable for biomedical implant applications.

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